

MLS Version 2 Cloud Ice Products and Validation Plan

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Changes of cloud ice products in V2.1

In the standard product file (IWC):

MLS-Aura_L2GP-IWC_v02-10-c04_2005d028.he5

Swath name: Ice water content (IWC)

- Useful pressure range: 68-261 hPa;
- Dynamic range: 0-120 mg/m³;
- Improved precision at pressures of 68-215 hPa;
- Reduced number of false alarms for pressures < 177 hPa;
- Improved retrieval for large IWC values, where V1.5 underestimates.

Swath name: Ice water path (IWP) – *New!*

- Based on low-tangent-height 240 GHz radiances;
- A slant path above ~6 km;
- Will be converted to the vertical column in v2.2;

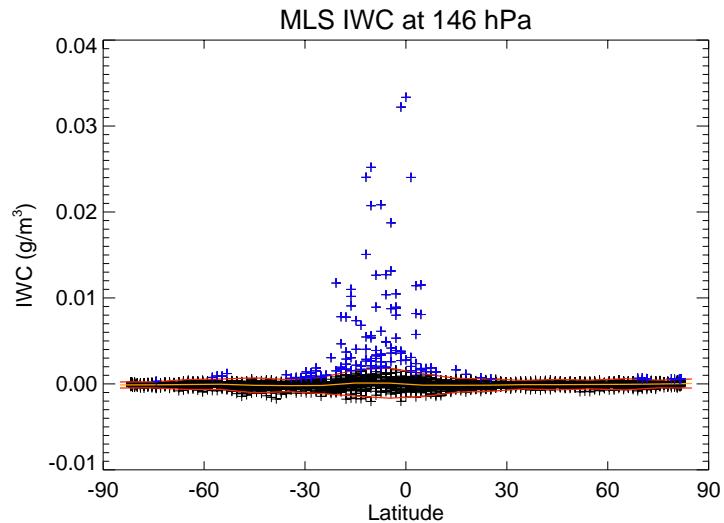
Provisional Release of V2.1 IWC

Caveats:

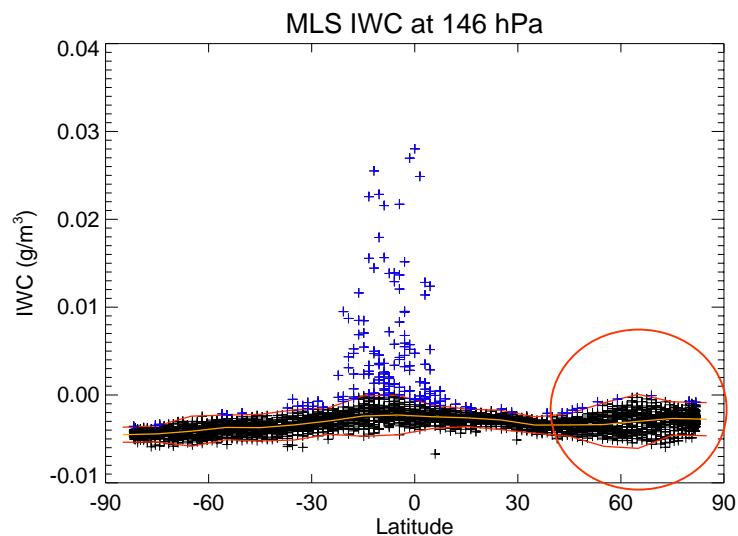
- Use the same procedure as in v1.5 to remove the bias;
- Use 3-sigma threshold to screen the data for cloud detection.
- No correction factor is needed for v2.1.

Estimated Precision (1 sigma)

Pressure (hPa)	V1.5 IWC Prec (mg/m ³)	V2.1 IWC Prec (mg/m ³)
83	0.04	0.03
100	0.05	0.04
121	0.09	0.06
147	0.39	0.21
177	0.86	1.1
215	3.1	4.6
261	7.5	12.5



V2.1



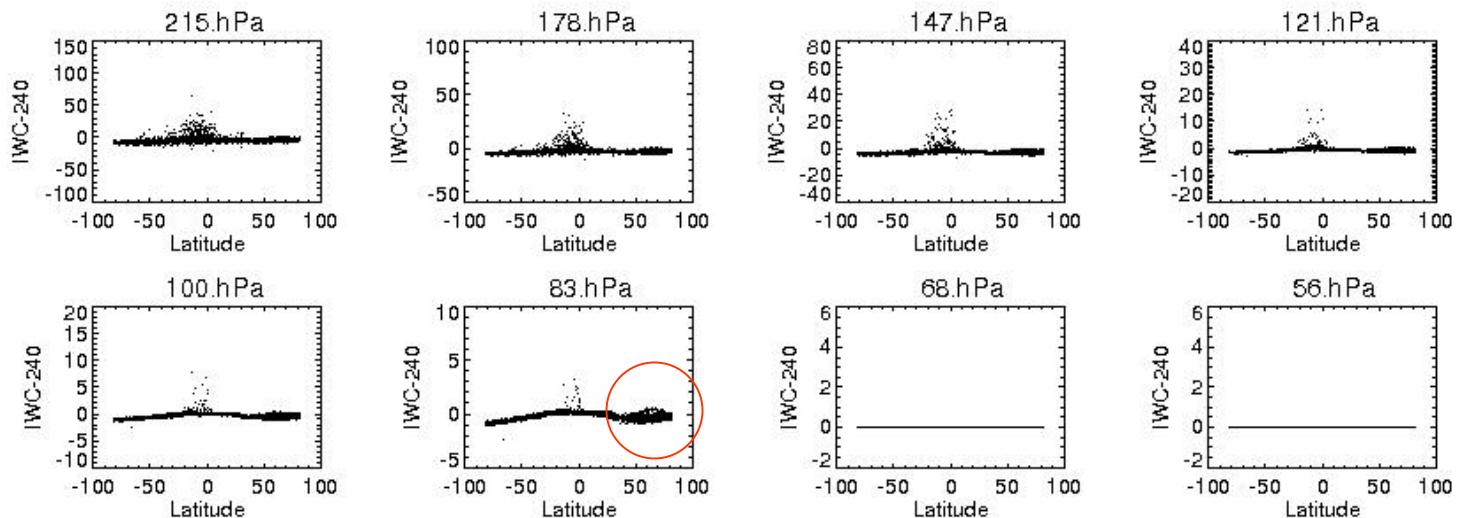
V1.5

V2.1 vs. V1.5 IWC: Improvements on biases and false alarms

2005d028

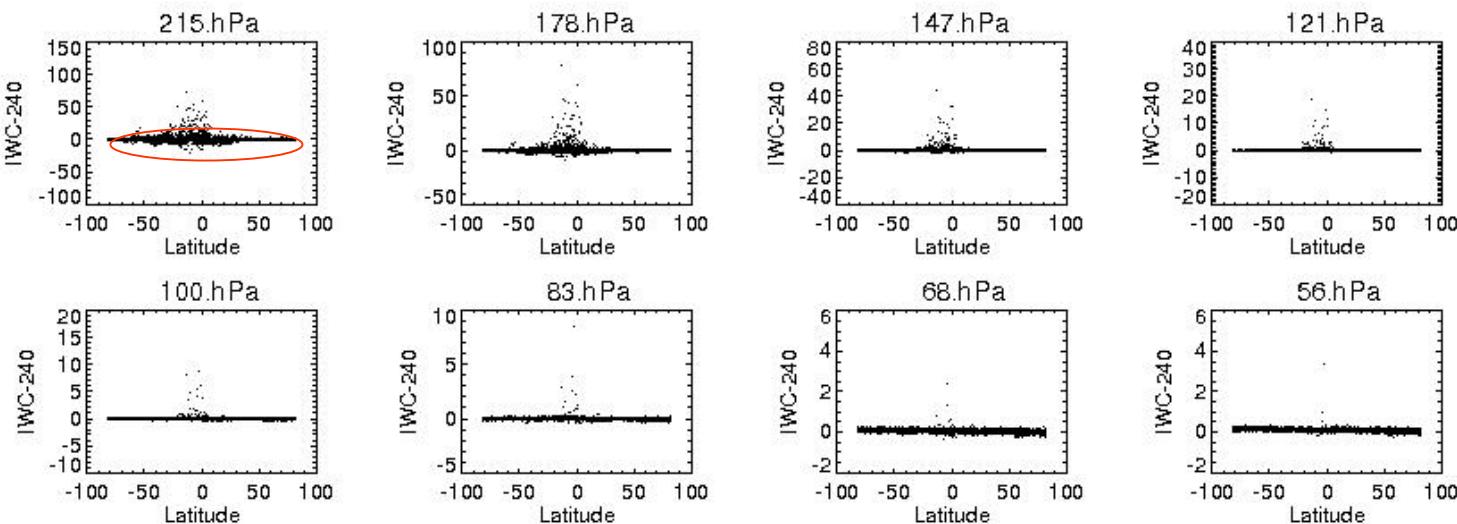
V1.5

- Biases;
- False alarms at high latitudes;



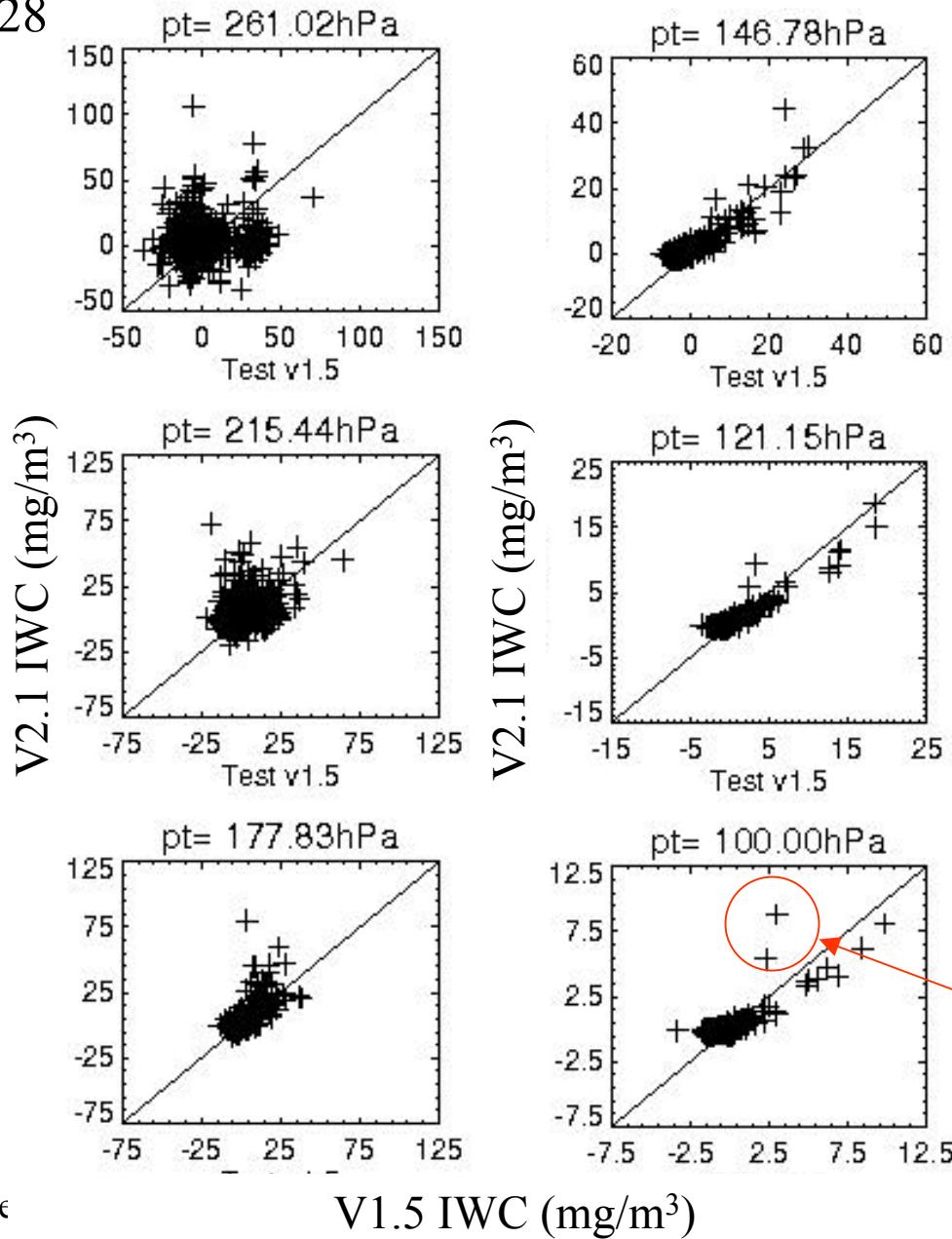
V2.1

- Little biases;
- Reduced false alarms at high latitudes;
- Slightly noisier at $p > 177$ hPa;



V2.1 vs. V1.5 IWC: Scatter plots

2005d028



- Consistent cloud detection between v1.5 and v2.1 at pressures < 178 hPa.
- More IWC > 50 mg/m³ in v2.1
- Better handling of volcano cases in v2.1
- Large differences at 215 and 261 hPa

Volcano clouds

V2.1 vs. V1.5 IWC: Time series

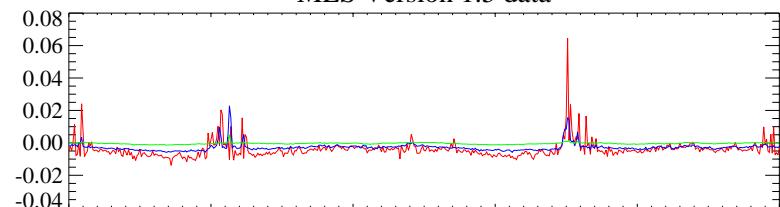
2005d028

MLS vs AIRS Data on January 28, 2005 (2005d028)
Red=215 hPa Pressure surface, Blue=147 hPa Pressure surface, Green=100 hPa Pressure surface

MLS vs AIRS Data on January 28, 2005 (2005d028)
Red=215 hPa Pressure surface, Blue=147 hPa Pressure surface, Green=100 hPa Pressure surface

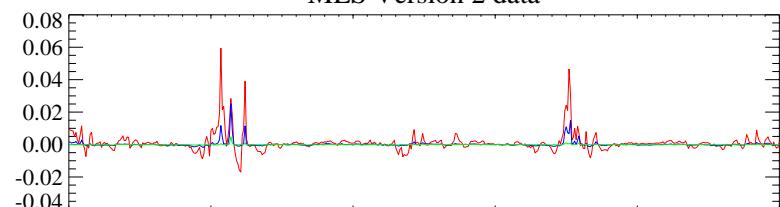
MLS V1.5
IWC
(g/m³)

MLS Version 1.5 data



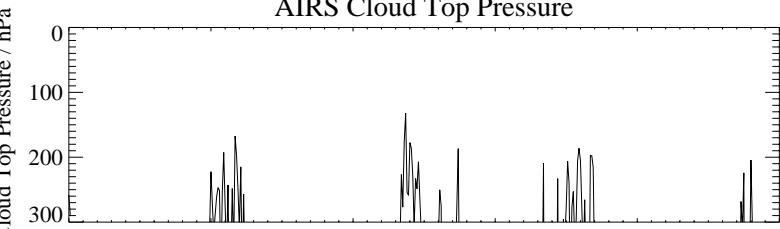
MLS V2.1
IWC
(g/m³)

MLS Version 2 data



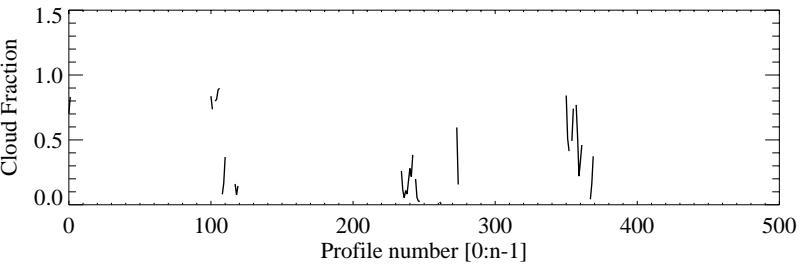
AIRS
Cld Top
Pressure
(hPa)

AIRS Cloud Top Pressure

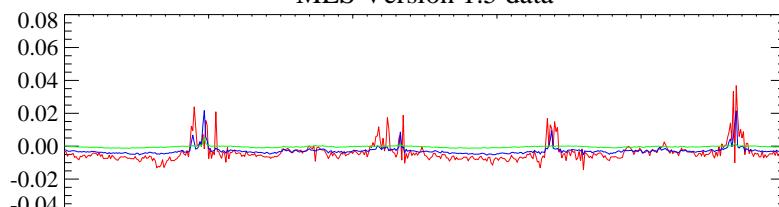


AIRS
Cld Frac

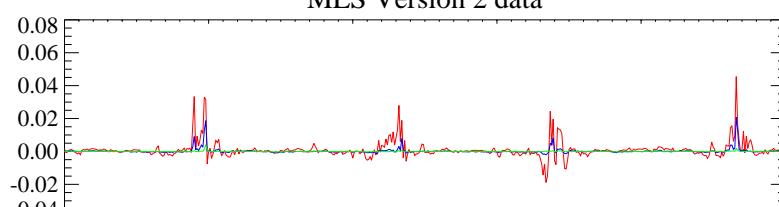
AIRS Cloud Fraction



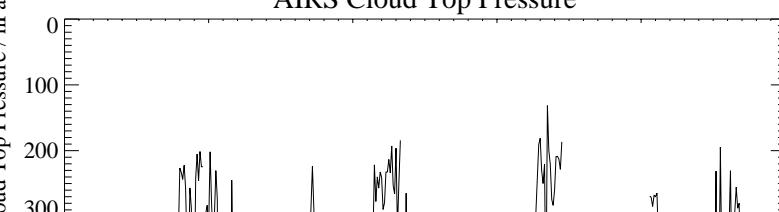
MLS Version 1.5 data



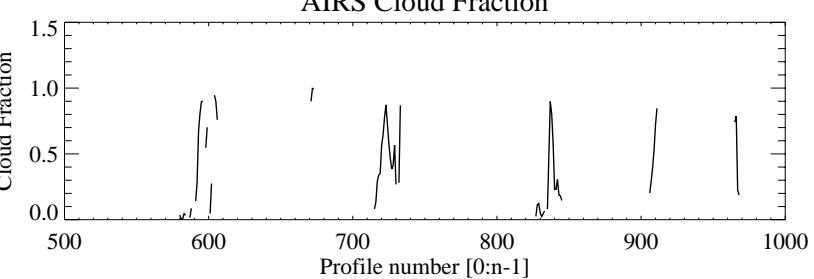
MLS Version 2 data



AIRS Cloud Top Pressure



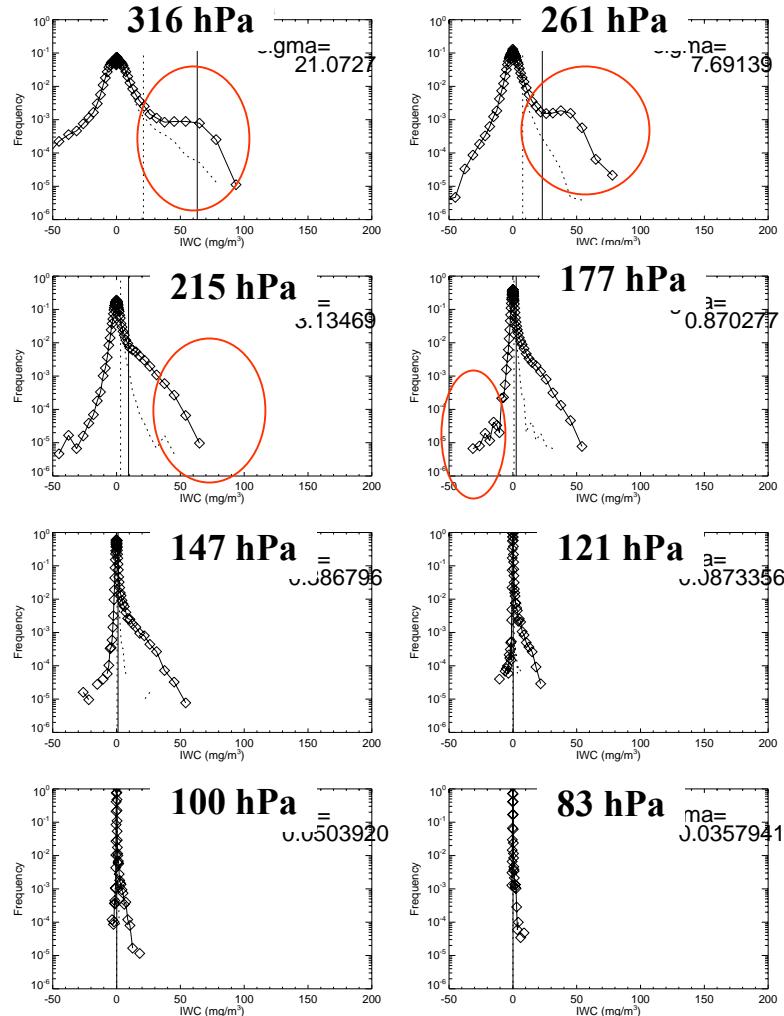
AIRS Cloud Fraction



V2.1 vs. V1.5 IWC statistics: Probability Density Function (PDF)

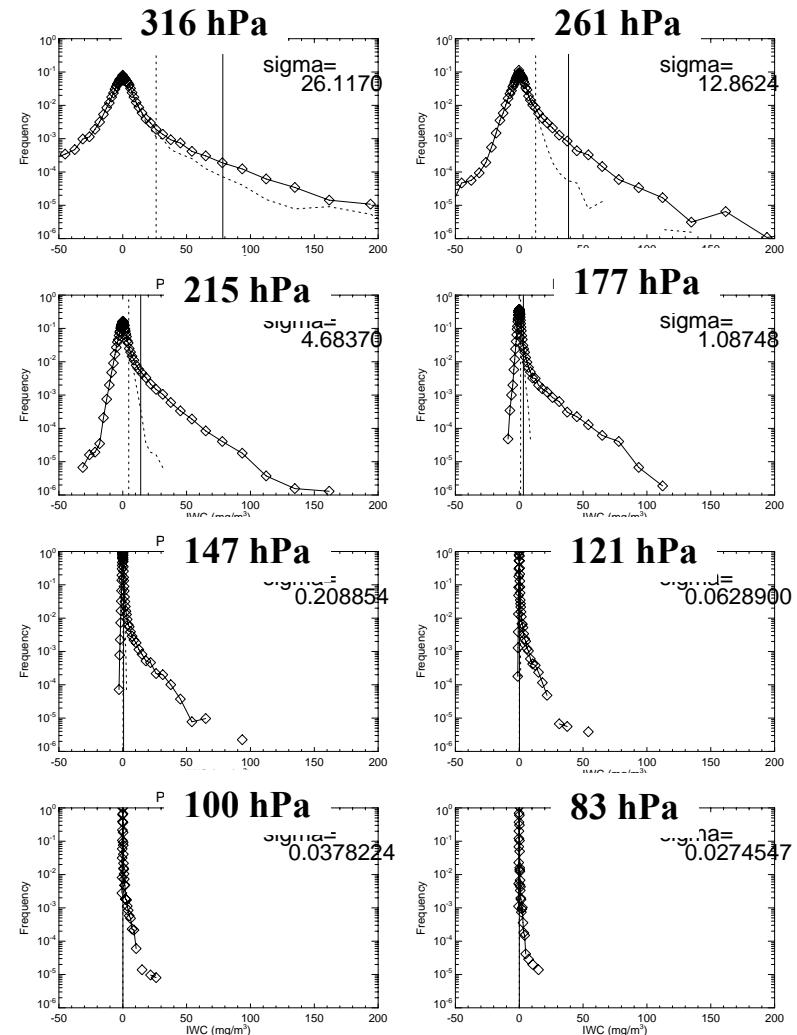
V1.5

- lacks of IWC $> 50 \text{ mg/m}^3$
- some large negative outliers
- latitude-dependent biases
- false alarms at high latitudes



V2.1

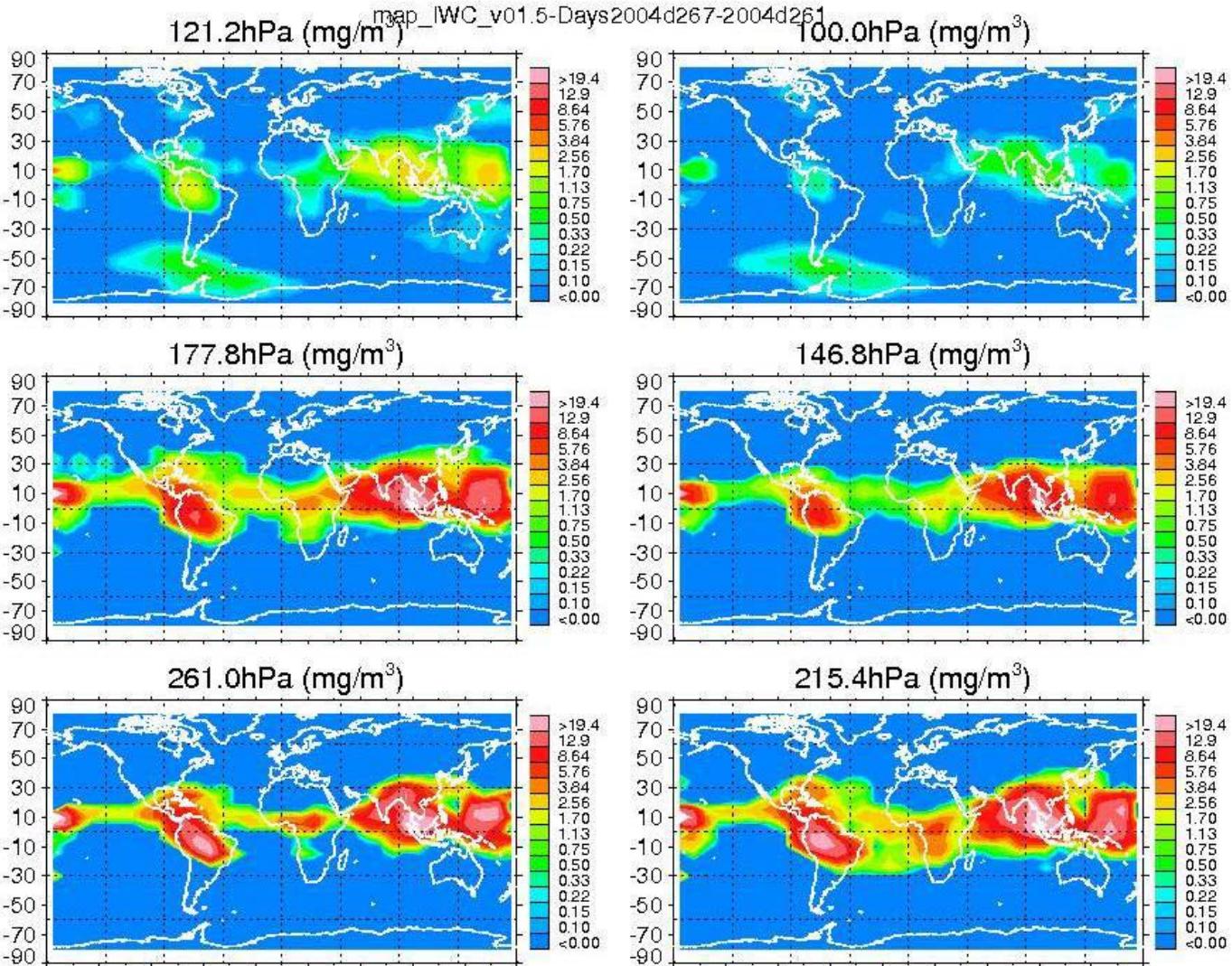
- more IWC $> 50 \text{ mg/m}^3$
- no large negative outliers
- little latitude-dependent biases
- reduced false alarms at high latitudes



Maps for 2004 d261, d267-269, d273

V1.5 IWC

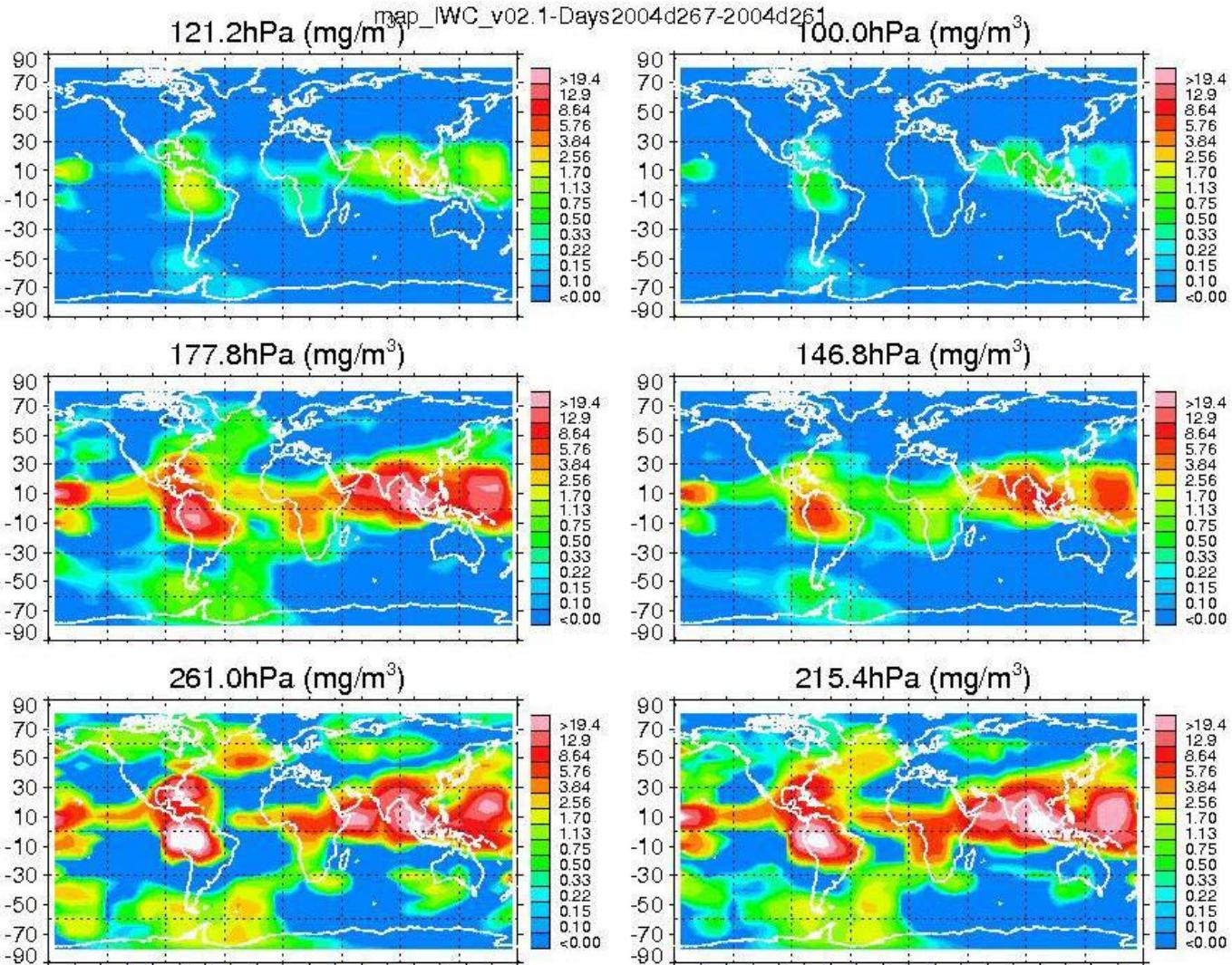
- Lacks of mid-latitude clouds
- Inconsistency among clouds at different levels near Patagonia



Maps for 2004 d261, d267-269, d273

V2.1 IWC

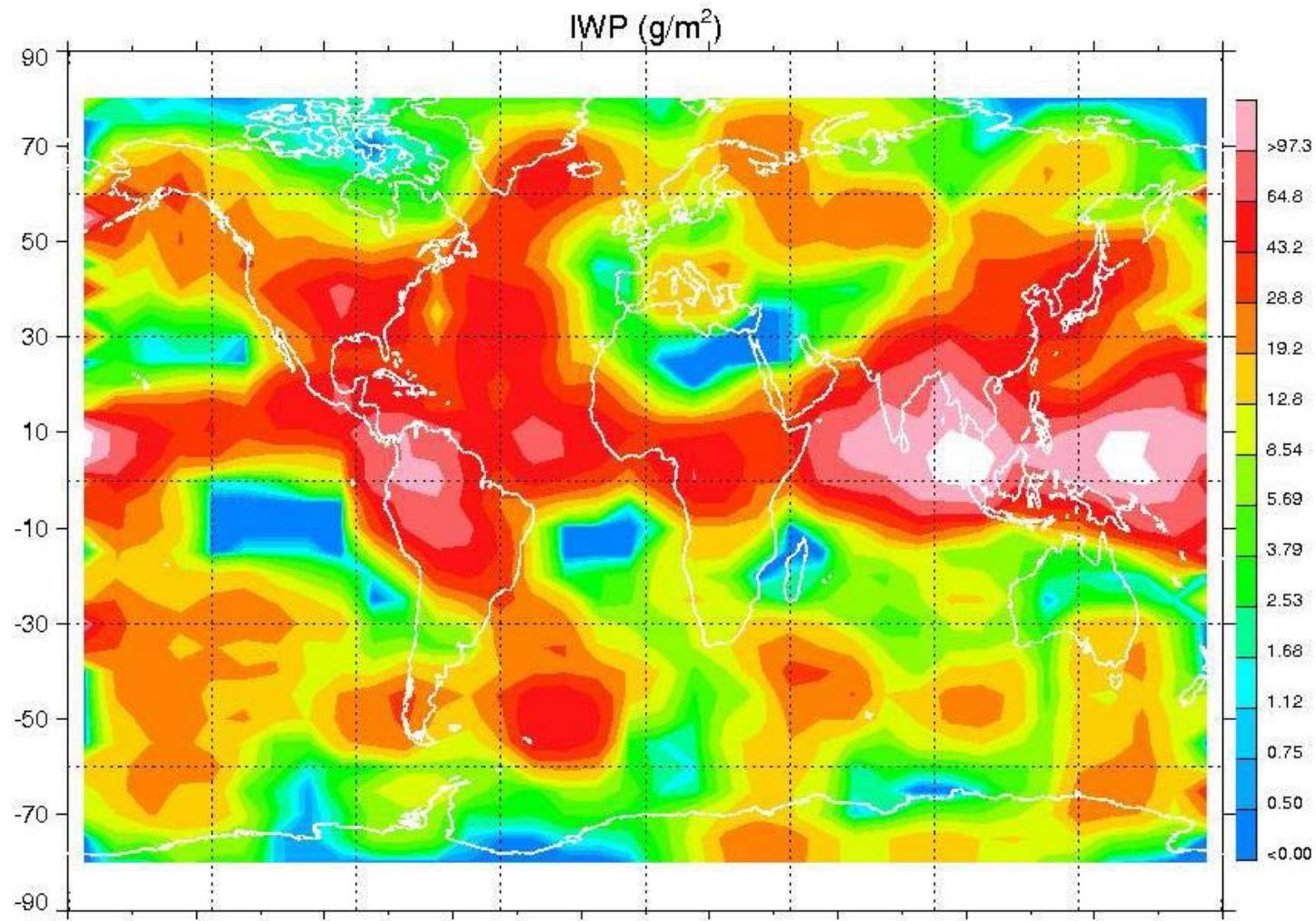
- Similar morphology at 147-100 hPa
- More mid-latitude clouds at 177-261 hPa



Map for 2004 d261, d267-269, d273

V2.1 IWP_{>6km}

map_IWP_v02.1-Days2004d267-2004d261



Validation Plans

IWC comparisons

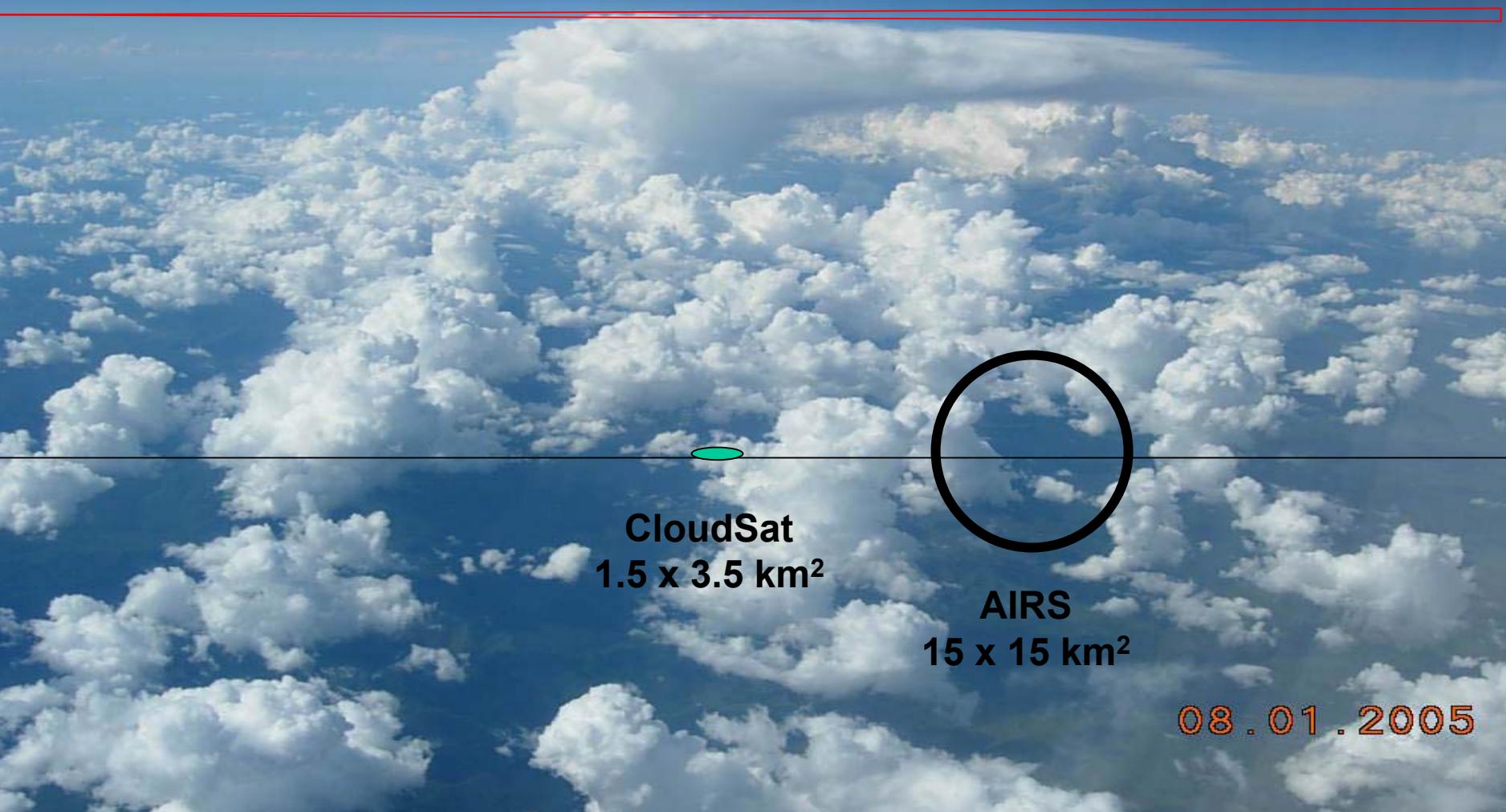
- CloudSat and TRMM (D. Wu, A. Heymsfield, + ..)
- AIRS (J. Jiang)
- OMI (J. Jiang)
- MODIS (H. Pumphrey + students)
- Ground-based radars (D. Wu + ...)

IWP comparisons

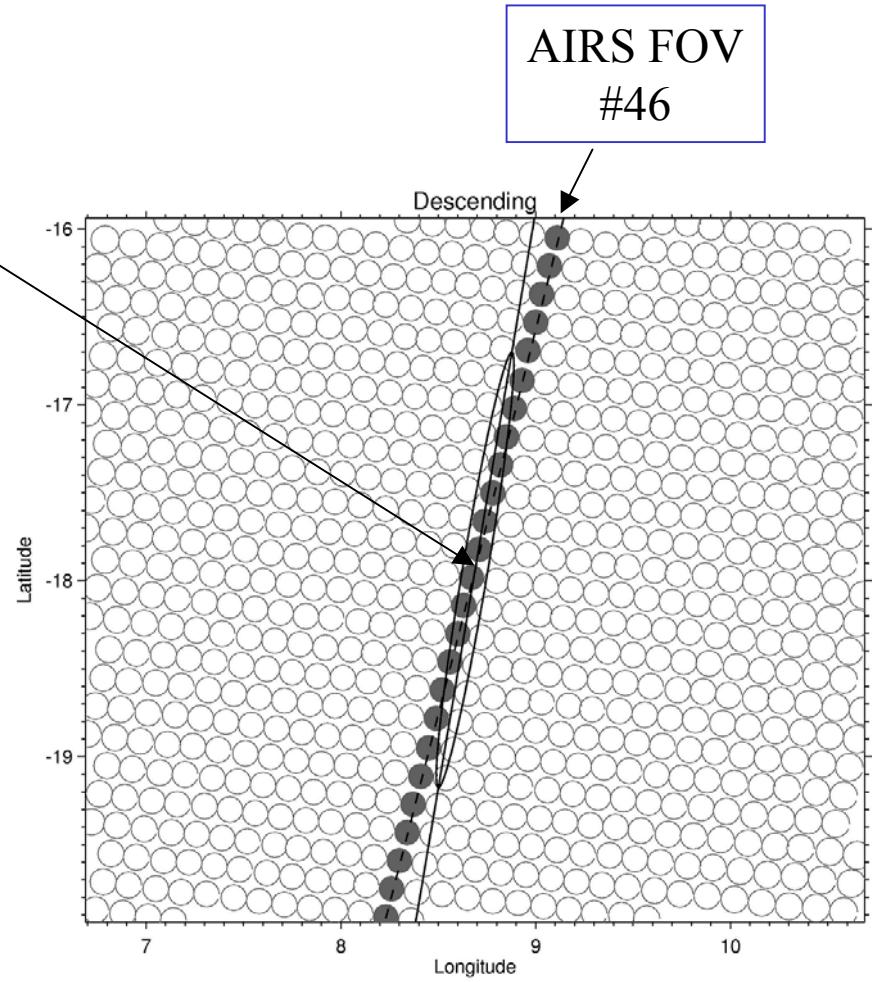
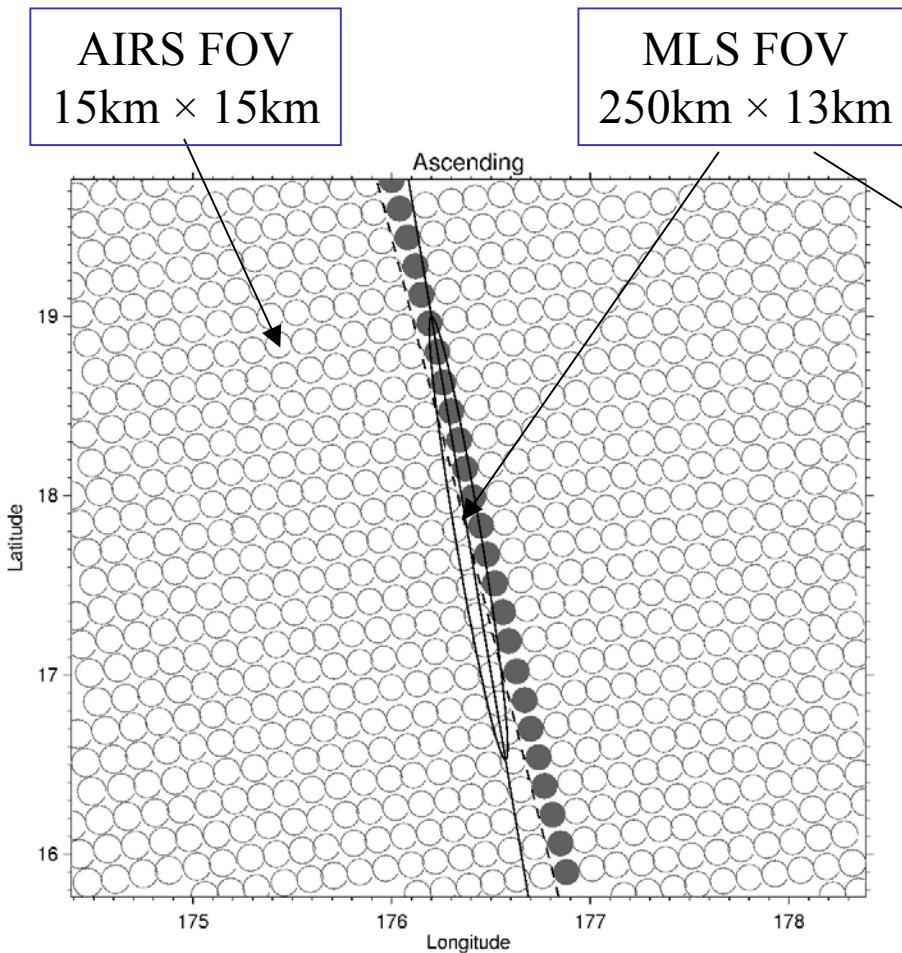
- CloudSat (D. Wu, A. Heymsfield, + ...)
- AMSU-B (D. Wu)

Sampling and Noise Issues

MLS: ~200 x 13 km²



Spatial variability: sampling differences and averaging consideration



September 12, 2006

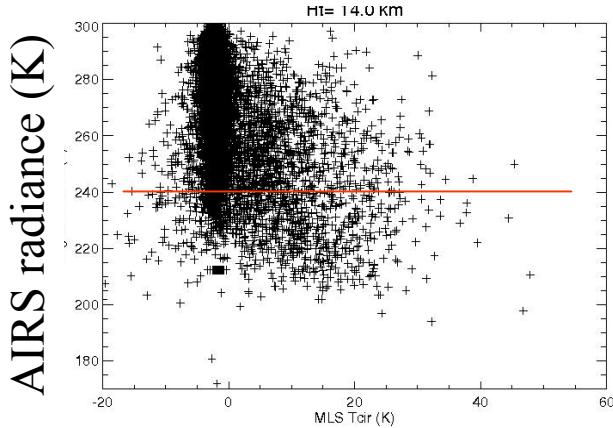
Aura Science Meeting, Boulder, CO

Lesson from MLS-AIRS Radiance comparisons

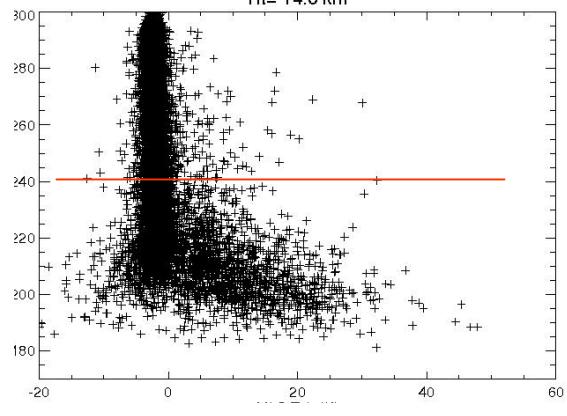
147 hPa or ~ 14 km

AIRS 734 cm^{-1}
Rad = 240 K

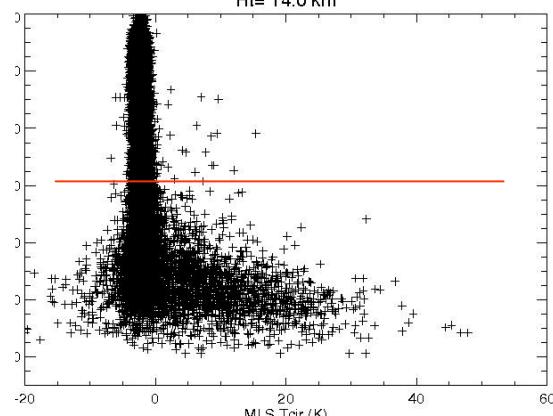
230 km long,
avg. AIRS Rad



230 km long,
min AIRS Rad



610 km long,
min AIRS Rad



MLS cloud-induced radiance (K)

The quantities that are not addable:

- IR/Vis/UV cloud induced radiances
AIRS, MODIS, OMI
- Cloud top pressure/height
maybe, limited/small area?

The quantities that are addable:

- Cloud IWC: MLS, CloudSat, TRMM
- Cloud IWP: MLS, CloudSat, AMSU-B
- Cloud fraction: MLS + many

Effect of Instrument Noise

Cloud detection threshold
is the common problem for
all techniques.

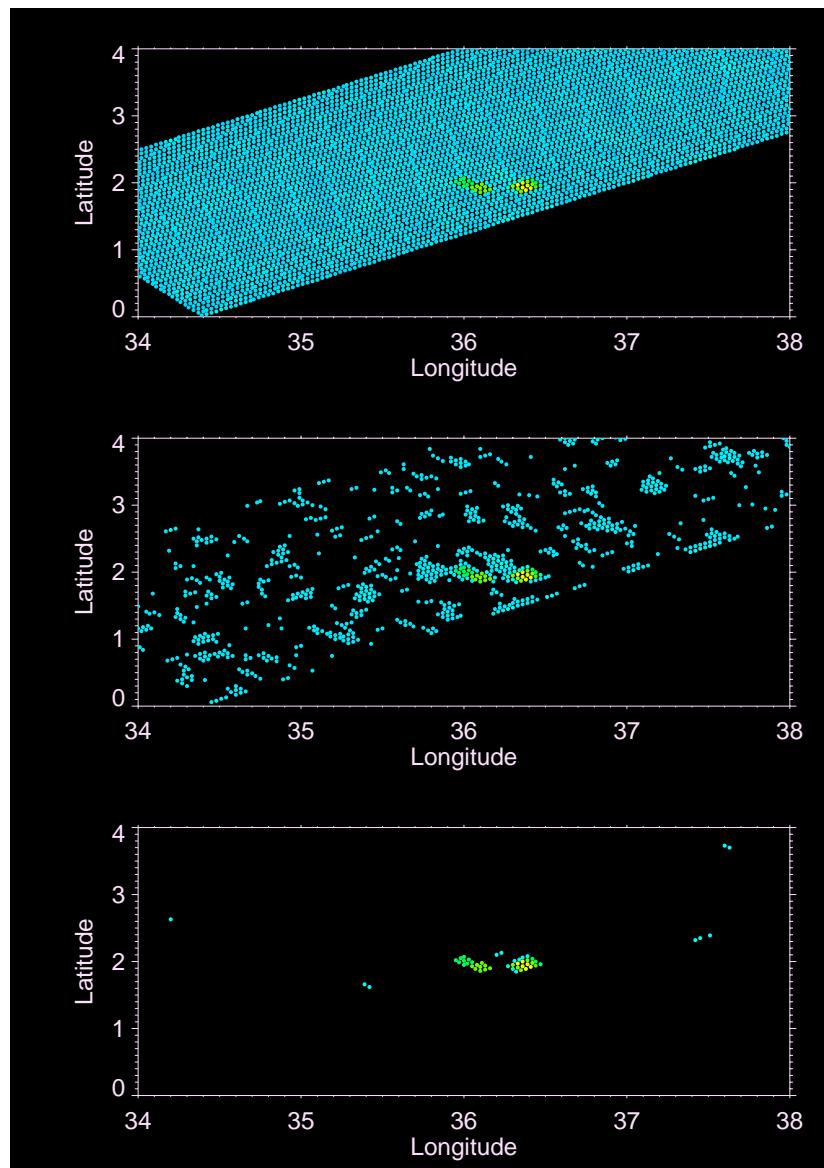
Comparisons between
model and observation
should not depend on what
thresholds are used!

Raw data

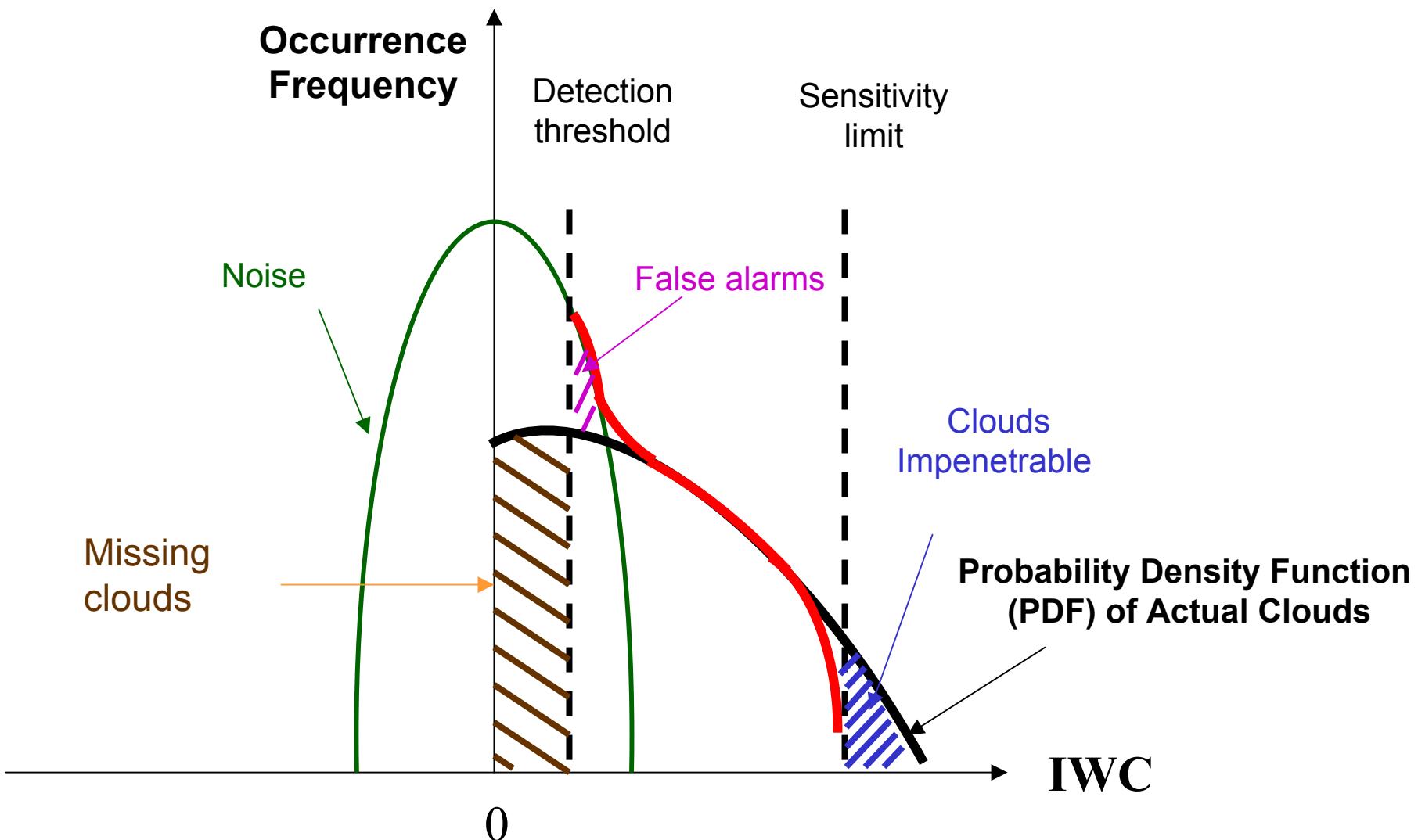
Threshold
30.2 dBZ

Threshold
30.6 dBZ

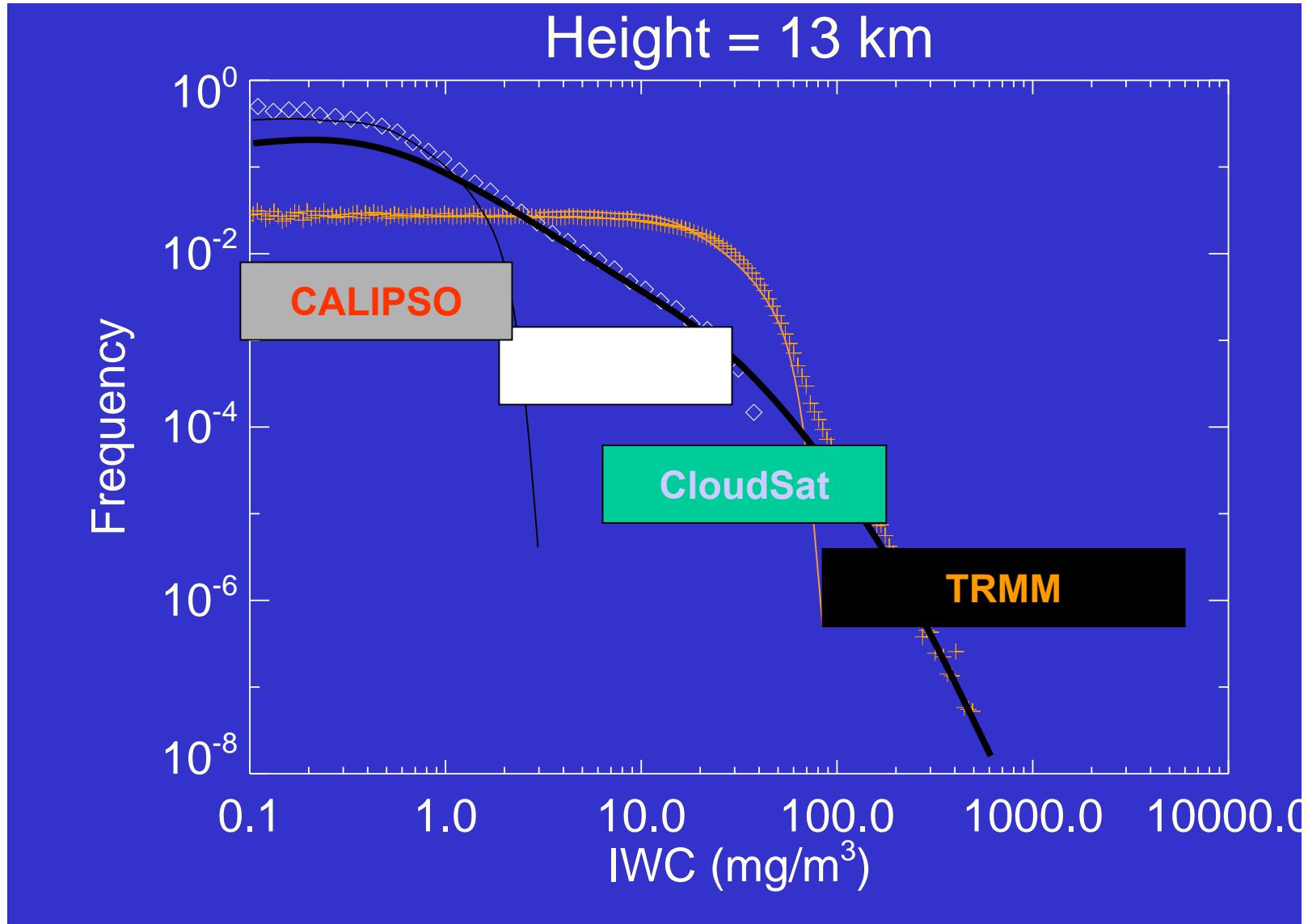
TRMM Radar Reflectivity at 15 km



Cloud Measurements Limited by Noise and Sensitivity



Connecting IWC Observations Through PDF



Summary for MLS Cloud Ice Measurements

- Significant improvements of v2.1 over v1.5 IWC;
- New $IWP_{>6\text{km}}$ product in v2.1
- Caution required for comparing/validating cloud products (e.g., quantities that are addable or not);
- PDFs as very useful diagnostics to compare precision, accuracy and sensitivity of IWCs measured by different sensors;
- Importance of spatial averaging because IWC statistics are sensitive the size of the volume averaged.

Additional Notes:

- New SO_2 retrieval in v2.1 (Contact Bill Read @ MLS);
- Ability of separating between volcano clouds and SO_2 in v2.1.